MARKED-UP VERSION OF THE ORIGINAL SPECIFICATION

Method For Correcting Speed Feedback In A Permanent-Magnet Motor

[0001] This application is a Continuation of copending PCT International Application No. PCT/FI02/00650 filed on July 31, 2002, which designated the United States, and on which priority is claimed under 35 U.S.C. § 120, and this Nonprovisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No(s). 20011598 filed in Finland on August 1, 2001, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a method ~~as defined in the preamble of claim 1~~ for correcting speed feedback in a synchronous permanent-magnet motor.

2. Description of the Background Art

[0003] The problem is that, in the prior art, speed feedback in a synchronous permanent-magnet motor changes slowly e.g. as a function of temperature. When used as an elevator drive machine, the permanent-magnet motor is typically subjected to long-lasting peek-level loads, during which the temperature of the elevator machine rises. As the machine is developing heat, the

speed feedback sensor attached to the machine becomes heated. In the present context, the above-mentioned speed feedback sensor is a tachometer. Thus, the speed information obtained from the tachometer changes as a function of the temperature of the machine and especially of the tachometer. In the above-mentioned situation, the speed feedback information typically includes a 3% gain and zero error, which is visible in the entire speed regulation system. A rise in the machine temperature may naturally also be due to development of heat in the elevator shaft when a synchronous permanent-magnet motor is used as an elevator drive motor.

[0004] Previously known solutions attempted in order to deal with the above-mentioned problem ~~include~~ by generating an advance estimate of the speed signal error produced in the above-described manner and eliminating the error on an average. However, this method would not lead to accurate and reliable correction of the error.

[0005] Another known way of solving the aforesaid problem is based on measurement of speed feedback. In this case, a known distance is traversed at a known speed, so the speed feedback error can be corrected at the operating point in question. The problem with this method is the continuously changing operating point, so the correction is naturally inaccurate.

SUMMARY OF THE INVENTION

[0006] ~~The object of the invention is~~ **It is therefore an object of the**

present invention to eliminate the abovementioned drawback in static correction of speed feedback.

[0007] A specific object of the invention is to disclose a method for continuous correction of speed feedback in a synchronous permanent-magnet motor that is better than prior-art methods.

~~In precise terms, the method of the invention for correcting speed feedback in a synchronous permanent-magnet motor is characterized by what is presented in the characterization part of claim 1. The features characteristic of certain other preferred embodiments of the invention are presented in the subclaims.~~

[0008] The method of the invention provides significant advantages as compared with prior art.

[0009] The method of the invention allows advantageous correction of non-linearities in the measurement of the speed of a synchronous permanent-magnet motor. A specific object of the invention is to correct the slow drift of speed feedback in the measurement of the speed of a synchronous permanent-magnet motor. This aforesaid drift may occur e.g. in relation to temperature.

[0010] Another advantage of the method of the invention is that it is an adaptive method, which means that, once the initial values have been set, the method learns the correct factors. In addition, in the calculation of the parameters

to be used in the method, it is possible to include a forgetting factor, which makes it possible to perform the changing of the aforesaid parameters in a controlled manner. ~~Via~~ By controlled changing of the above-mentioned parameters, it is possible to achieve some correction of the direction dependence of the zero and gain error.

[0011] The present invention concerns a method for correcting speed feedback in a synchronous permanent-magnet motor. In the most preferred embodiment of the invention, the averages of speed reference and speed measurement for constant-speed downward travel are calculated. In a corresponding manner, the average of speed reference and speed measurement for constant-speed upward travel is calculated. Next, the gain and zero factors to be used in the calculation are identified and the measured speed measurement value is corrected to the correct value.

[0012] All the above-mentioned averages of speeds are calculated using the sum of the respective speeds and the number of samples. For example, the average of the speeds of downward constant-speed travel is calculated by dividing the sum of the speeds of constant-speed downward travel by the number of samples of downward constant speed. Similarly, the average of the speeds of constant-speed upward travel is calculated by dividing the sum of the speeds of constant-speed upward travel by the number of samples of upward constant speed.

[0013] In a preferred embodiment of, the invention, the synchronous permanent-magnet motor of the method is used as an elevator drive machine.

[0014] According to the method, the speed gain factor and the speed zero factor are first assigned certain initial values. After this, new speed gain and zero factors are calculated.

[0015] According to the invention, the aforesaid speed gain factor and speed zero factor are updated by a forgetting factor. This aforesaid forgetting factor is an exponential factor. This aforesaid forgetting factor is used in the present method so that, by applying the aforesaid forgetting factor, measurement samples of recent history are given more weight as compared with earlier ~~later~~ measurement samples.

~~In the foregoing, the invention has been described by way of example while different embodiments of the invention are possible within the scope of the inventive idea defined in the claims.~~

[0016] **Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the**

art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitive of the present invention, and wherein:

[0018] Fig. 1 is an illustrative cross-section of a permanent magnet motor; and

[0019] Fig. 2 is a flow chart of a method according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION

[0020] Fig. 1 shows a simplified illustration of a permanent magnet motor 1. The permanent magnet motor 1 has a shaft 3 that is fixedly attached to a rotor 5. The rotor 5 is typically a magnet that rotates because of an electrical force generated by windings of a stator 7. The permanent magnet motor 1 also further includes a speed feedback sensor 9 that measures a rotational speed of the permanent magnet motor 1. This speed feedback sensor 9 is shown to be located on the shaft 3 in Fig. 1, however, the speed feedback sensor 9 can also be provided in any suitable location on the permanent magnet motor 1.

[0021] Fig. 2 is a flow chart of a method according to a preferred embodiment of the present invention. In step S1 averages of a speed reference and speed measurement for downward travel is calculated. In step S3 averages of a speed reference and speed measurement for upward travel is calculated. Then, in step S5, the gain and zero factors are identified. Thereafter, in step S7, the measured speed measurement value is corrected

<u>**on the basis of the identified gain and zero factors.**</u>

[0022] <u>**The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are to be included within the scope of the following claims.**</u>

<u>**What is claimed is:**</u>